

USDA  
NATURAL RESOURCES  
CONSERVATION SERVICE

DELAWARE CONSERVATION  
PRACTICE STANDARD

**DIKE**

CODE 356  
(Reported by Ft.)

**DEFINITION**

A barrier constructed of earth or manufactured materials.

**PURPOSES**

- To protect people and property from floods.
- To control water level in connection with crop production; fish and wildlife management; or wetland maintenance, improvement, restoration, or construction.

**CONDITIONS WHERE PRACTICE  
APPLIES**

All sites that are subject to damage by flooding or inundation and where it is desired to reduce the hazard to people and to reduce damage to land and property.

Sites where the control of water level is desired.

The dike standard does not apply to sites where NRCS conservation practice standards Pond (378), Water and Sediment Control Basin (638), Diversion (362), or Terrace (600) are appropriate. Dikes used to reduce flooding are normally constructed adjacent and/or parallel to a stream, river, wetland or water body and are

not constructed across the stream, river or water body. Dikes used to control water levels usually have small interior drainage areas in relation to the surface area of the regulated water level.

**CONSIDERATIONS**

**Flood of Record.** For Class I dikes, the flood of record should be considered when establishing the top of dike elevation.

**Location.** When locating the site for the dike, consider the foundation soils, property lines, setbacks from property lines, exposure to open water, distance to streambanks, availability of outlets by gravity or pumping, buried utilities, cultural resources, and natural resources such as wetlands, natural areas, and fish and wildlife habitat.

Fluvial geomorphologic concepts contained in National Engineering Handbook (NEH), Part 653, Stream Corridor Restoration Principles, Processes and Practices should be considered when placing a dike near a stream.

**Berms.** Give special consideration to wider berms, additional setbacks, or protecting the berm side slope when adjacent to actively eroding or moving streams to protect the dike for its design life.

**Adverse Impacts.** Adverse environmental impacts from the proposed dike will be evaluated. Any increases in flood stage caused by dike-induced flow restrictions will be evaluated for adverse impacts to unprotected areas. Adverse impacts should be minimized.

This practice has the potential to affect National Register listed cultural resources or eligible (significant) cultural resources. These may include archeological, historic, or traditional cultural properties. Care should be taken to avoid adverse impacts to these resources. Follow NRCS state policy for considering cultural resources during planning.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

## **CRITERIA**

### **Criteria Applicable to All Purposes**

**Classification.** The dike classification is determined by the hazard to life, the design water height, and the value of the protected land, crops, and property. Classification must consider land use changes likely to occur over the life of the dike.

Dikes are classified as Class I when located on sites where failure may cause loss of life or serious damage to homes, primary highways, industrial buildings, commercial buildings, major railroads or important public utilities.

All dikes with a design water height of more than 12 feet above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be classified as Class I.

Dikes are classified as Class II when located on sites where failure may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, or high value crops.

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal.

**Constructed Elevation.** The constructed elevation of a dike whose purpose is to prevent flooding shall be the sum of the following:

1. The water elevation attained by a flood or high tide of the design frequency shown in Table 1 with the critical duration and timing. This is the design high water.
2. The larger of the minimum freeboard in Table 1 or the wave height caused by wind or boat traffic.
3. The allowance for settlement.

The constructed elevation of a dike whose purpose is to control water level shall be the sum of the following:

1. The water elevation at the highest water level control.

2. The rise in water height above the highest water level control caused by a flood of the design frequency shown in Table 1. This is the design high water.
3. The larger of the minimum freeboard shown in Table 1 or the wave height caused by wind of the design frequency shown in Table 1.
4. The allowance for settlement.

**Settlement.** Settlement shall be based on an analysis of the fill material, foundation material and condition, and compaction methods.

In lieu of an analysis, the allowance for settlement shall be as follows:

1. For dikes constructed of compacted earth fill material shall be a minimum of 5% of the dike height.
2. For Class II or Class III dikes, constructed of fill material that is hauled from off-site, dumped, and shaped (referred to as "dumped and shaped"), the allowance for settlement shall be a minimum of 15% of the dike height. For fill material that is excavated adjacent to the dike and dropped from the excavator (referred to as "dropped"), the allowance for settlement shall be a minimum of 20% of the dike height. The allowance for settlement of dumped and shaped or dropped organic soil fill material shall be a minimum of 40% of the dike height. Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

For the purpose of this standard, organic soils are described as follows:

1. Soil layers that are not saturated with water for more than a few days at a time are organic if they have 20 percent more organic carbon; or
2. Layers that are saturated for longer periods, or were saturated before being drained, are organic if:

- (1) They have 12 percent or more of organic carbon and no clay, or
- (2) 18 percent or more organic carbon and 60 percent or more clay, or
- (3) A proportional amount of organic carbon, between 12 and 18 percent, if the clay content is between 0 and 60 percent.
4. All soils described in the local soil survey as an organic soil.
4. The minimum side slope ratio of constructed berms shall be 2:1 (Horizontal:Vertical).

**Dike Materials.** Manufactured materials are erosion resistant materials such as concrete, PVC, steel, or other material that provides the required structural strength and durability for the dike. Dikes constructed of manufactured materials shall have a structural analysis completed for the various loads the dike will be subjected to during its life. These include hydrostatic, ice, uplift, earth, and equipment. The dike shall be analyzed for stability using acceptable safety factors for each loading condition.

**Top Width and Side Slopes.** The minimum top widths and side slopes for earth embankments shall be as shown in Table 1.

All dikes must be accessible for maintenance activities. Typically, this may be along the top of the dike or along the berm. Access roads shall provide adequate width for the maintenance equipment and inspection vehicles. The minimum width for vehicular traffic should be 12 feet. Provide wider areas for passing and turning around at regular intervals. Access roads may need to be controlled to prevent vandalism, accidents, and damage.

Earth dike materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the engineer or designer. Fill materials shall contain no frozen soil, sod, brush, roots, or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to placement and compaction of the fill. The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

**Berms.** The need for a constructed berm on an embankment will be based on the results of an embankment and foundation stability analysis. If a stability analysis is not performed, all earth dikes shall have berms either constructed or occurring naturally on both sides meeting the following criteria:

**Embankment and Foundation Seepage.**

Embankment and foundation drainage and seepage control shall be designed on the basis of site investigation, laboratory data, seepage analysis, and stability analysis. The resulting design shall minimize seepage, prevent piping or undermining, and provide a stable embankment and foundation.

1. Constructed berms shall be at a constant elevation and sloped away from the dike.
2. Where dikes cross channels, ditches, borrow areas, streams, sloughs, swales, gullies, etc., they shall have a berm constructed on each side. The top elevation of these berms shall be at least 1 foot above the average ground surface on each side of the channel, ditch, borrow area, stream, slough, swales, gully, etc., and sloped away from the dike.
3. The minimum top width of natural or constructed berms shall be as shown in Table 1.

An analysis is required on all Class I dikes that have a height of six (6) feet or greater and Class II dikes that have a height of eight (8) feet or greater.

In the absence of more detailed data and analysis, the following criteria for a foundation cutoff apply for Class I dikes less than 6 feet in height, Class II dikes less than 8 feet in height and Class III dikes:

1. Minimum of H feet deep for  $H < 3$  feet.
2. Minimum of 3 feet deep for  $H \geq 3$  feet.

3. Minimum of 4 feet bottom width.
4. 1:1 or flatter side slopes.

A stream, channel, ditch, borrow area, slough, swale, gully, etc. shall be far enough away from the dike so that the extension of a line drawn from the design high water elevation on one side of the dike to the dike toe on the opposite side shall not intersect any stream, channel, etc. (See figure 1). This line criterion applies to both sides of the dike. This criterion will minimize the hazard to the dike caused by piping through the foundation.

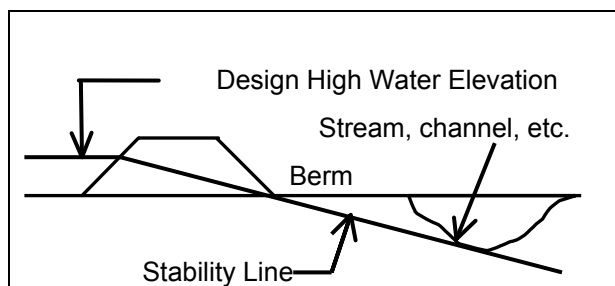


Figure 1

**Interior Drainage.** Dikes to prevent flooding shall be provided with interior drainage systems for the area being protected. The interior drainage system shall prevent flood damage to the interior area from a flood of the design frequency in Table 1 for both the 1-day and the 10-day storm duration. The interior drainage system may include storage areas, gravity outlets, and pumping plant as needed to provide the required level of flood protection.

**Pipes.** Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet shall meet the requirements for PRINCIPAL SPILLWAYS as found in NRCS TECHNICAL RELEASE 60 - Earth Dams and Reservoirs, except for the minimum size requirements.

Pipes through all other dikes shall meet the requirements for a principal spillway in NRCS Conservation Practice Standard, Ponds (378).

Dikes shall be protected from scour at pipe inlet and outlet locations by appropriate measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible. Pump discharge pipes shall be equipped with a

flexible connection or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge pipe.

**Slope Protection.** Slopes of earthen dikes shall be protected from sheet, rill, and gully erosion; erosion from flowing floodwaters; and wave action created by wind and/or boat traffic. Erosion protection measures such as non-woody vegetation, berms, rock riprap, sand-gravel, or soil cement shall be utilized as needed.

**Regulatory Requirements.** Dikes shall meet the requirements of all federal, state, and local laws or regulations.

## **SPECIFICATIONS**

Plans and specifications for clearing and shagging shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice. Documentation shall be in accordance with the section "Supporting Data and Documentation" in this standard.

## **OPERATION AND MAINTENANCE**

Operation and Maintenance (O&M) requirements for all dikes will be provided to the landowners. For Class I dikes with a height greater than 12 feet, an emergency action plan meeting the requirements of 500.70 of the National Operation and Maintenance Manual shall be completed prior to construction of the dike. For Class I and Class II dikes, a detailed written operation and maintenance Plan in accordance with 500.40 through 500.42 of the National Operation and Maintenance Manual shall be completed and provided to the owner.

## **SUPPORTING DATA AND DOCUMENTATION**

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location the dike(s) on the conservation map.
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit,

specifics as to alternatives discussed, decisions made, and by whom.

### **Field Data and Survey Notes**

The following is a list of the minimum data needed:

1. Plan view sketch.
2. Establish and describe a temporary benchmark.
3. Profile along centerline of dike.
4. Soil investigation logs and notes.
5. Location and elevation of soil borings.
6. Location of and elevation of the top of bank and toe of slope of any stream, channel, ditch, gully or borrow area that is adjacent to the dike alignment.
7. Location and profile of drainage-ways crossed by the dike alignment, as appropriate.
8. Location and description of trees and other obstacles that may need to be removed.

### **Design Data**

Record on appropriate engineering paper. For guidance on the preparation of engineering plans see Chapter 5 of the Engineering Field Handbook - Part 650. The following is a list of the minimum required design data:

1. Locate the practice on the farm plan map in the case file.
2. Determine dike classification and list appropriate dike design criteria, including map.
3. Determine water elevation attained by a flood or high tide of the design frequency obtained from Table 1 using HEC-RAS or by other approved method.
4. Determine the constructed elevation of the dike, using Table 1.

5. Determine the top width, berm width and side slope ratio using Table 1.
6. Develop a stage-storage/discharge relationship for interior drainage areas, as appropriate.
7. Provide for interior drainage, as appropriate.
8. Provide for the control of erosion during and following construction.
9. Drawings should show the following as a minimum: plan view showing alignment; profile along centerline of dike; cross-sections of dike at appropriate intervals, construction details (and notes), and soil logs.
10. Show job class on the plan.
11. Estimated Quantities.
12. Planting plan with seed, lime, fertilizer, and mulching requirements.
13. Written Operation and Maintenance Plan.

### **Construction Check Data/As-Built Plans**

Record on survey notepaper, NRCS-ENG-28, or other appropriate engineering paper. Survey data will be plotted in red. The following is a list of minimum data needed for As-built documentation:

1. Profile notes along centerline of top of completed dike.
2. Cross-section notes at appropriate locations along the completed dike.
3. The elevation of the interior drainage conduit inverts (inlet and outlet), as appropriate.
4. The diameter, length, and type of material for the conduits.
5. Statement as to the condition or adequacy of vegetation on the dike, and other disturbed areas.

6. Type and location of fencing and safety features where appropriate.
7. Final quantities and documentation for quantity changes. Materials certifications as appropriate.
8. Sign and date check-notes and plans by someone with appropriate approval authority. Include statement that practice meets or exceeds plans and NRCS practice standards.

Table 1 – Minimum Design Criteria for Dikes

Classification	Material <sup>1/</sup>	Height (H) in Feet <sup>2/</sup>	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio <sup>3/</sup> (H:V)	Berm Width in Feet
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		>6 to 12	100	2	10	Note 4/	Note 4/
		>12 to 25	100	3	12	Note 4/	Note 4/
		>25	100	3	14	Note 4/	Note 4/
	Manufactured	0 to 8	100	H/4	N/A	N/A	Note 4/
		>8 to 12	100	2	N/A	N/A	Note 4/
		>12	100	3	N/A	N/A	Note 4/
Class II	Earth	0 to 6	25	H/3	6	2:1	12
		>6 to 12	25	2	8	2:1	15
	Manufactured	0 to 8	25	H/4	N/A	N/A	Note 4/
		>8 to 12	25	2	N/A	N/A	Note 4/
Class III	Mineral Soils	0 to 3	10	H/3	4	2:1	8
		>3 to 6	10	1	6	2:1	8
		>6 to 12	25	2	8	2:1	8
	Organic Soils <sup>5/</sup>	0 to 2	10	H/2	4	2:1	10
		>2 to 4	10	1	6	2:1	10
		>4 to 6	10	2	8	2:1	15

<sup>1/</sup> Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.

<sup>2/</sup> Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies.

<sup>3/</sup> Minimum side slope ratios are for compacted earth fill. Dumped earth fill without compaction will be flatter.

<sup>4/</sup> Side slope ratios and berm widths shall be determined by a stability analysis.

<sup>5/</sup> Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.